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METHOD, DEVICE AND FORMING ELEMENT FOR PRODUCING GROOVES IN A CONCRETE SLAB AND BALLASTLESS SUPERSTRUCTURE FOR A TRACK

[VERFAHREN, VORRICHTUNG UND SCHALUNGSELEMENT ZUR HERSTELLUNG VON NUTEN IN EINER BETONPLATTE SOWIE SCHOTTERLOSER OBERBAU FÜR EIN GLEIS]

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Description /1*

The present invention relates to a method for manufacturing grooves that run parallel to each other according to the preambles of Claim 1 and/or 7. The present invention also relates to a ballastless superstructure for a track according to the preamble of Claim 15. Besides that, the present invention relates to a device for manufacturing two grooves that run parallel to each other according to the preamble of Claim 16 and/or 18. Finally, the present invention relates to a forming element for manufacturing grooves according to the preamble of Claim 19.

The present invention deals very generally with the manufacturing of undercut grooves especially those that run in parallel in a concrete slab, which especially are used to hold elastically deformable profile elements and track rails that can be inserted into them for formation of a ballastless superstructure for a track. A superstructure of this type is known from DE-A-196 04 887.

In a ballastless superstructure according to DE-A-196 04 887, the track rails are held exclusively by profile elements of elastically deformable material. To do this, each track rail has a rail foot designed as a push-in foot that is provided with undercut fixing and/or abutment surfaces. The track rail is inserted, with the push-in foot and the rail rib holding the rail head that are connected to it, into an adapted rail groove of the profile element. In inserted state, the track rail is secured by opposing surfaces of the profile element,

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*Numbers in the margin indicate pagination in the foreign text.

which contact the fixing surfaces of the push-in foot. In addition, the track rail is fixed in its position in that the profile element is held on both sides of the rail rib and on the underside of the rail head, and possibly laterally on the rail head, so that the track rail is held in a defined way.

In turn, the profile element is encased with a slab, preferably consisting of concrete, holding the profile element with the track rail. To do this, the concrete slab has a groove that runs in the rail direction that is open toward the top for holding the profile element. A simple and secure fastening of the profile element in the groove is achieved in that the groove has undercut sections into which an expanded insert end of the profile element engages. In particular, in this case the track rail, the profile element and the groove are coordinated to each other in such a way that the push-in foot of the track rail extends into the expanded insert end of the profile element so the push-in foot presses and/or tensions the profile element at one insert end into the undercut sections of the groove so that the profile element is securely held in the groove when the track rail is inserted.

At the open end, the groove holding the profile element in the concrete slab is widened for forming preferably slightly sloped support surfaces, on which the profile element supports itself as an intermediate layer between the underside of the rail head and the support surfaces.

In the superstructure named above, a high-quality precision formation of the grooves in the concrete slab is critical for correct alignment of the track rails. Since preferably two track rails that run in parallel are held by a common concrete slab, at least over a specific length, in addition to the form precision of each individual groove for holding a profile element, the grooves must be precisely aligned in their positions with respect to each other and/or designed with high quality precision in their absolute positions.

In previous ballastless superstructure designs for track elements – so-called fixed roadways – longitudinal grooves are provided in a carrier layer consisting e.g. of asphalt or concrete only for fastening concrete ties lying on it from above (monoblock or dual-block ties) in transverse direction to the rail longitudinal extension, as shown for example in DE-U-94 15 311. However, in this case, the track rails are each mounted on ties and separate rail supports. As a consequence, the precision requirements of the longitudinal grooves are significantly lower here than in the previously described superstructure.

The state of the art gives no information on how the manufacturing of undercut grooves in a concrete slab can be implemented, especially with the required precision.

The present invention is based on the object of providing a ballastless superstructure, a device and a forming element as mentioned at the beginning, which make possible the high-quality precise manufacturing of preferably at least two grooves running

parallel to each other with undercut sections in a concrete slab in the simplest, most cost effective way possible and especially makes possible continuous manufacturing on site.

The object above is achieved by a method according to Claim 1 and/or 7, a ballastless superstructure according to Claim 15, a device according to Claim 16 and/or 18 and a forming element according to Claim 19. Advantageous further developments are the objects of the subclaims.

According to a preferred process variation, the non-undercut sections and the undercut sections of the grooves are milled into the hardened concrete slab in separate steps. In this case, the non-undercut sections of the grooves are milled into the concrete slab first, for example using roller-shaped milling cutters. Then the undercut sections of the grooves are milled or cut in the concrete slab, for example by means of titled milling or cutting disks. If necessary, any longitudinal sections of concrete material that may have remained after the cutting process are removed by breaking and cleaning; this means if necessary the grooves are reprofiled and, for example cleaned by suctioning away loose material.

Instead of the milling and/or cutting disks sloped with respect to the vertical around the groove longitudinal axis for creating the undercut groove sections, an end-milling cutter can be used with a rotary axis that extends in groove longitudinal direction or, alternatively, vertically. As a supplement, or alternatively, the groove wall can also be cut (or recut) using a water jet.

In any case, the successive machining and/or manufacturing of the non-undercut sections and the undercut sections makes possible the use of at least relatively simply structured tools and streamlined, fast work with high precision.

The effort needed for dimensionally precise milling and/or subsequent milling of the grooves can be reduced considerably if the grooves are previously roughly milled, for example with only a slot shape or T-shaped groove cross section, in which concrete of the concrete slab that is still flowing can be deformed with a slip form paver during manufacturing of the concrete slab. Depending on the tolerance of the preliminary forming, a recutting of the groove walls to the desired dimension will then be adequate.

This results in an especially simple and precisely manufactured ballastless superstructure for a track if the undercut section of the /2 groove is designed so that it is essentially trapezoidal in cross section in such a way that the angled groove wall of the undercut section can be produced by milling and/or cutting disks that are sloped, as described above. To do this, the inclination of the angled groove wall of the undercut section with respect to the center plane of a following slot-shaped section of the groove is less than the diagonal defined by the longitudinal edge at the transition from the angled groove wall to the slot-shaped section and the upper-side longitudinal edge of the slot shaped section lying diagonally opposite in the cross section.

An especially advantageous device, especially for carrying out one of the procedures mentioned above, for manufacturing at least two grooves running parallel to each other with undercut sections in a concrete slab is characterized by a movable carrying device, a positioning device held by it with all the milling devices required for simultaneous milling of the two grooves in the concrete slab that can be adjusted relative to it and an adjusting device for adjusting the positioning device relative to the holding device for mutual alignment of the milling devices. A simple and high-quality parallel production of the grooves is possible because of the arrangement of the milling devices necessary for manufacturing the two grooves on a common bearing frame of the positioning device and its correct positioning by means of the adjusting device.

Preferably all the milling devices necessary for manufacturing a groove, like a roller-shaped milling cutter and correspondingly angled milling and/or cutting disks and/or other cutting, profiling and cleaning device are arranged on the device, in succession in the groove longitudinal extension in the area of each groove to be manufactured so that the common adjustment is already adequate for a high-quality precise positioning of the devices that produce and/or machine the two grooves and in any case, replacement devices for the individual devices only have to be provided depending on tool wear.

A second preferred process variation for manufacturing preferably at least two grooves running parallel to each other with undercut sections in a concrete slab is characterized in that the forming

elements forming the grooves are aligned and encased with concrete when the concrete is poured for the slab or in recesses in the concrete slab. This method makes it possible to easily carry out a few variation possibilities.

According to one embodiment variation, the forming elements are aligned and fixed in their position on a fixed, especially asphalt, substrate before the concrete is poured for the concrete slab and/or they are encased with concrete. Preferably in this case, two forming elements forming two grooves parallel to each other are fixed in the desired position by a common detachable holding and/or positioning device, preferably by screwing or pinning on the substrate. Then the forming elements are encased with concrete. They remain as lost forms in the concrete slab and form the walls of the grooves.

Another embodiment variation provides that the forming elements are held roughly, and preferably exactly aligned, by a holding and/or positioning device and then encased with concrete. In this process, the manufacturing effort is especially low since a fixed fastening of the forming elements before encasing with concrete is not necessary. To produce two grooves that run in parallel, the detachable holding and/or positioning device mentioned above can be used for simultaneous positioning of the corresponding forming elements. Besides that another alignment and/or precision alignment can occur to secure the required precision of the alignment after encasing of the forming elements in concrete and before the concrete hardens when there has only been a rough alignment.

Alternatively, the forming elements are not placed into the concrete that is not yet hardened (still flowing) until after the concrete is poured for the concrete slab, especially by shaking, and especially in pairs by means of a common positioning device. The placement of the forming elements into the flowing concrete can occur by a rough formation of corresponding grooves in the concrete, especially by corresponding displacement elements mounted on a slip form paver in order to make the subsequent placement of the forming elements easier and to only cause a sight displacement of concrete during the placement.

After the encasing with concrete, a recalibration of the forming elements can occur, especially in pairs simultaneously by means of a common positioning device in order to achieve and/or ensure precise alignment.

For holding, positioning and/or aligning the forming elements of two grooves running parallel to each other, an apparatus is provided that comprises a positioning device held by it that can be adjusted relative to it with two holding devices for detachable holding of the two forming elements to be encased with the concrete slab, and forming the two grooves, and an adjusting device for adjusting the positioning device relative to the carrying device for common alignment of the two forming elements. This device makes high productivity and precise alignment of the forming elements possible with simple structure and low costs.

Different types of forming elements can be used. According to a preferred embodiment variation, each forming element is designed in several parts, whereby the forming element has an upper part that at least partially forms the non-undercut sections of a groove and a detachable lower part that can be connected with the upper part and forms at least the undercut sections of this groove. In this combined forming element, the upper part is taken out of the groove, while the lower part is left, at least in the undercut sections of the groove, after an adequate solidification of the concrete but before final hardening. In this case, the surface of the upper part that comes in contact with the concrete preferably consists of steel, while for decreasing the pull-out resistance, a special coating of the surface is preferred, for example of Teflon. The lower part that is provided e.g. with a longitudinal groove for inserting it on the upper part is preferably manufactured of a relatively soft material and will not be removed from the groove until after the concrete has solidified and/or hardened, whereby it is destroyed. This results in a relatively simple groove production with relatively little effort.

Alternatively the forming element can also be encased, in its entirety, as a lost form in the concrete slab or appropriate recesses /3
of the concrete slab and form the walls of the groove to be produced. This means, for example, a relatively thin-walled forming element having adequate form stability that has the desired groove shape can be placed, roughly aligned by a slip form paver in the concrete that still has flow properties by a corresponding positioning device,

especially designed as named above, e.g. with positioning shoes that glide along in the forming element and then aligned.

Alternatively, or additionally, the forming element can have a greater wall thickness, i.e. a decreased and/or deviating groove cross section, e.g. slot-shaped or T-shaped, so that after the concrete hardens a dimensionally precise machining of the forming element is possible for producing the desired groove cross section with precise alignment. This has the advantage that with appropriate material selection for the forming element, a relatively simple, cost-effective and precise groove production is made possible. In this process, the subsequent machining of the surface of the forming element can especially correspond to the machining sequence already explained above during milling and/or cutting of the groove in the concrete slab, whereby in turn an at least partially trapezoidal design of the undercut section of the groove appears to be especially advantageous.

In the following, the present invention will be described in more detail using the drawings of preferred embodiments. They show:

Fig. 1 shows a cross section view of a concrete slab with a groove according to the suggestion, an inserted profile element and an inserted track rail;

Fig. 2 shows a cross section view of the groove according to Fig. 1 during a manufacturing step;

Fig. 3 shows an illustration of a groove comparable to Fig. 2 with modified cross section;

Fig. 4 shows a groove with a different groove cross section during manufacturing using an end-milling cutter;

Fig. 5 shows a schematic representation of a device for simultaneous milling of two grooves parallel to each other;

Fig. 6 shows a side view of the device according to Fig. 5;

Fig. 7 shows a cross section of a forming element according to a first embodiment perpendicular to its longitudinal extension;

Fig. 8 shows a schematic representation of a device for simultaneous positioning two forming elements that run in parallel;

Fig. 9 shows a cross section of a forming element according to a second embodiment perpendicular to its longitudinal extension;

Fig. 10 shows a cross section of a forming element according to a third embodiment perpendicular to its longitudinal extension; and

Fig. 11 shows a cross section of a forming element according to a fourth embodiment perpendicular to its longitudinal extension.

Fig. 1 shows a groove **1** according the suggestion in cross section, perpendicular to the longitudinal extension with non-undercut sections **2** and undercut sections **3** in the area of the closed end that is formed in a concrete slab **4** that is indicated in part. In the groove **1**, an elastically deformable profile element **5** is used that has a rail groove **6** running in longitudinal direction, into which a track rail **7** is inserted for forming a ballastless superstructure **8**. The track trail **7** has a rail foot **9** designed as a push-in foot that is connected with a rail head **11** by way of rail rib **10** that has a reduced cross section. With track rail **7** inserted, the push-in foot **9** is

located essentially in the area undercut sections **3** arranged in the closed end of groove **1**, so that the profile element **5** is tensioned by the push-in foot **9** in the area of the undercut sections **3** of the groove **1**, whereby both the track rail **7**, as well as the profile element **5**, is held in the groove **1**.

In parallel to the groove **1** shown in Fig. 1, another corresponding groove that is not shown, preferably with mirror-symmetrical groove cross section, run in the concrete slab **4** and holds another track rail **7** that is not shown. Both track rails for a track for a railway vehicle, especially for a high-speed train.

The lower corners of the trapezoidal undercut can also be angled according to the dotted lines. Insertion into the groove **1** is significantly simplified with correspondingly milled and/or at least narrowed design of the profile element **5** in insert direction.

The cross section illustration according to Fig. 2 shows a design variation for manufacturing a groove 1 in the concrete slab **4**. After the concrete hardens, first the undercut sections **2** of the groove **1**, and if necessary also surface areas of the concrete slab **4**, was milled out using a milling cutter that is not shown, for example, one that is roller-shaped. Fig. 2 shows the non-undercut sections **2** and **2F** that have already been removed in that way, in dotted lines. Then the undercut sections **3**, at least those arranged on the closed groove end, i.e., arranged on the groove base if groove **1** is open toward the top, are milled by means of a milling or cutting disk, which is slanted,

e.g., according to Fig. 2 or 3. Fig. 2 shows this in the essentially symmetrical undercut of groove **1** for one side, a corresponding machining of the other side follows. Depending on the desired cross section shape of groove **1**, the machining tool and/or the disk **12** can be angled peripherally, e.g., according to the dotted lines.

Other optionally provided undercut sections **3'** of groove **1** can be milled out accordingly.

Depending on the thickness and/or milling or cutting width of the disk **12** or another tool, adhering sections **13** of concrete material that run in longitudinal extension can remain standing during cutting or recutting of the undercut sections **3**, as shown in Fig. 3. These sections **13** are then removed in a subsequent profiling step, for example by breaking and then cleaning of groove **1**, especially by suctioning out the loose material.

In contrast to Fig. 2, the cross section of groove **1** in the embodiment according to Fig. 3 is mirror symmetrical to the vertical center plane **14**. However, in both cases the undercut sections **3** are at least partially essentially triangular in cross section and/or trapezoidal when taken together, which makes possible the simple manufacturing mentioned above.

Fig. 3 shows that the inclination α of the diagonal groove wall of the undercut section with respect to the center plane **14** of a slot-shaped section **15** following the undercut section **3** is smaller than the diagonal **18** defined by longitudinal edge **16** at the transition from the

diagonal groove wall with respect to the slot-shaped section **15** and the upper longitudinal cross section **17** that lies diagonally opposite in the cross section. This design makes possible the use of tools /4 that are adjusted diagonally, like the disk **12**, for manufacturing and/or machining the diagonal groove wall in the undercut section **3.**

Fig. 4 shows the groove **1** with an alternative cross section shape, in which an undercut section **3** that is circular follows the closed side of groove **1**, at least in the essentially slot-shaped section **15.** After the non-undercut sections **2** have been milled out from the concrete slab, or alternatively the non-undercut sections **2** of groove **1** that extend between the undercut sections, as already described in connection with the design variation according to Fig. 2, the undercut sections **3** are milled out by means of a device **20,** which on its lower end has a finger-like milling tool **21** that can rotate around the axis of rotation extending in longitudinal direction of groove **1.** Due to continuous movement of the device **20** in the longitudinal direction of the groove, the undercut sections **3** of groove **1** in concrete slab **4** are created and/or machined to size by the rotating tool **21.**

Fig. 5 shows a schematic representation of an embodiment example of a device **22** for manufacturing two grooves **1** that run parallel to each other, with undercut sections **3**, in a concrete slab **4** according to one of the methods described above. The device **22** comprises a carrying device that preferably spans the two grooves to be produced

with a chassis **24** that can be supported on the concrete slab **4** or another substrate or on aligned rails so that the device **22** can be driven in groove longitudinal extension. The carrying device **23** holds a positioning device **25** that comprises a common carrying frame **26** for at least two milling devices **27** for simultaneously milling out and/or machining the two grooves **1.** The milling devices **27** are thus arranged offset on the carrying frame **26,** perpendicular to the longitudinal extension of grooves **1.**

Device **22** also comprises an adjusting device **28,** which is only indicated schematically, by means of which the carrier frame **26,** together with the milling devices, can be rotated in horizontal and vertical direction, as well as with respect to at least one vertical axis, and can be tipped relative to it in order to position the milling devices **27** in such a way that the grooves **1** can be milled, cut or machined in another way to the desired dimensions with high quality precision. To do this, the adjusting device **28** especially has a control device that is not shown for exact positioning of the carrying frame **26** and thus the machining devices and tools. In addition, the correct position of the grooves **1** and/or of the milling devices **27** are controlled and/or checked and if necessary corrected by means of precision measurement and/or precision level elements and corresponding control of the device **22,** especially the adjusting device **28.**

On the right side of the illustration according to Fig. 5, the front milling device **27** and milling devices **27** that are arranged after them on both sides in the groove longitudinal direction are left out for the sake of clarity.

It can be seen from the schematic illustrations according to Figs. 5 and 6 that the positioning device **25** and/or the carrying frame **26** is connected to the carrying device **23** and/or the adjusting device **28** by means of at least one joint **29**, indicated here schematically. In particular, the positioning device **25** can be adjusted in many ways with respect to carrying device **23** by means of the adjusting device **28**, as indicated by the arrows in Figs. 5 and 6, so that by appropriate adjustment and setting of the machining tools and/or the milling devices **27**, a high quality precise position and dimensional accuracy of the grooves **1** to be produced can be achieved. In particular, the absolute position of each groove **1**, its spatial course and the relative position of the grooves **1** with respect to each other can be specified by appropriate adjustment capability of device **22**. In this case, special attention should be paid to the spacing of the grooves **1**, the height of each individual groove, the sloping position of the individual grooves with respect to their longitudinal extension and the special, possibly curved, longitudinal course of each groove **1** and their parallelism to each other.

Fig. 6 shows the device **22** according to Fig. 5 in a side view, perpendicular to the longitudinal direction of grooves **1** and thus

perpendicular to the machining device. Fig. 6 shows that several milling devices **27** and/or several machining tools of a milling device **27** can be arranged on a common carrying frame **26** in succession in the machining direction, whereby, e.g., each groove **1** is assigned at least one roller-shaped milling cutter **30** and two disk-like milling cutters **31,** that are set so that they are sloped with respect to the previously mentioned center plane **14,** as indicated by milling and/or cutting disks **12** according to Figs. 2 and 3.

The device **22** is preferably designed so that it can be driven in groove longitudinal direction and/or groove production direction, as indicated by arrow **32** in Fig. 5, so that a continuous machining and/or manufacturing of grooves **1** can occur.

Device **22** permits a continuous, dimensionally precise and simultaneous machining and/or production of two grooves **1** that run parallel to each other. Because of the common carrying frame **26** of the milling devices **27,** an especially precise positioning of the two grooves **1** with respect to each other is achieved with little effort. As a consequence, simple and cost-effective manufacturing of grooves **1** results so that a simple and cost-effective manufacturing of a ballastless superstructure **8** for a track is possible.

Fig. 7 shows a cross section perpendicular to the longitudinal extension of a first embodiment of a forming element **33,** which comprises a longitudinal profile **34** corresponding to the desired groove profile with rib-like support elements **35** arranged at specified

distances on the longitudinal profile **34**, which especially surround it on the outside. The support elements **35** are designed so that a fastening on the substructure **36** is possible, e.g., by means of screws **37**, pins or other fasteners. The support elements **35** are, as shown in Fig. 7, designed, e.g., as trapezoidal slab elements that cause a reinforcement and shape stability of the longitudinal profile **34** and can be fastened on the substructure **36** with mounting links **38** that preferably extend essentially horizontally and are arranged in the corner areas of its base edge.

The forming element **33** is aligned on the substructure **36**, for which, e.g., washers **39** are arranged for height adjustment between the mounting links **38** and the substructure **36** and then the aligned forming element **33** is fastened to the substructure **36** by way of mounting links **38**. Then the forming element **33** is encased with concrete and remains there as a lost form that forms the groove **1** to be produced.

In the embodiment example shown in Fig. 7, the forming element **33** is mounted on a substructure **36**, which also holds the concrete slab **4**. The substructure **36** is designed accordingly as an adequately strong bearing layer, preferably it is manufactured of asphalt or hydraulically bound material.

Alternatively, the forming element **33** can also be mounted in a /5
corresponding longitudinal recess in concrete slab **4** and then encased with concrete in the concrete slab **4** by filling the longitudinal recess.

To do so, a very precisely aligned groove **1** that has very good dimensional stability in its groove cross section can be produced using the forming element **33** with relatively little manufacturing effort. The wall of the groove is formed by the longitudinal profile **34**.

Preferably, the forming element **33** is manufactured of a plastic material with the desired properties with respect to bending strength, impact strength, temperature resistance, etc., or another material having the desired properties. Preferably the support elements **35** are designed so that they form one piece with the longitudinal profile **34** and are manufactured of the same material accordingly. Alternatively, however, the support elements can be manufactured of a different material and/or separately from the longitudinal profile **34** and not connected with the longitudinal profile until it is needed on site.

Fig. 8 shows a schematic representation of a preferred embodiment of a device **40** for manufacturing two grooves **1** that run parallel to each other with undercut sections **3** in a concrete slab **4** with the use of forming elements **33** according to the embodiment shown in Fig. 7. The device **40** is constructed essentially corresponding to device **22** so the same reference numbers are used for the same or similar devices and components.

In contrast to the device **22** shown in Figs. 5 and 6, instead of the milling devices **27**, the device **40** according to Fig 8 has at least two holding devices **41** that can be connected with the forming element

33 so that they can be released, e.g., by engaging in the longitudinal profile **34**, so that two forming element **33** that run parallel can be brought simultaneously into the desired position with dimensional precision by means of apparatus **40** using corresponding alignment of the positioning device **25** and can be fastened, for example on the superstructure **36**, by the fastening means already mentioned. Then the encasing with concrete occurs during manufacturing of the concrete slab **4**.

Instead of a preferably provided clamping fastening of each forming element **33** to at least one holding device **41** by means of a gripper arm, etc., each holding device **41** can also comprise a holding element that is not shown that can engage with form fit into the longitudinal profile and/or the undercut sections, which glides along in the longitudinal profile depending on the movement of the device **40** in the groove longitudinal extensions and in each case provides for correct alignment of the forming element **33** with appropriate control of the carrying frame **26** by the adjusting device **28**. If necessary, the holding devices **41**, as well as the milling devices can also be adjusted individually for position correction, especially in their height, as indicated by the double arrows.

Fig. 9 shows a cross section of the second embodiment of the forming element **33** for producing the groove **1**, perpendicular to the groove longitudinal extension. The forming element **33** is made of multiple parts, especially two parts. The forming element **33** comprises

an upper part **42** and a lower part **43** that is fastened on upper part **42** in such a way that it can be detached. In particular, the lower part **43** can be connected with the upper part **42** by snapping them together. This can be implemented, e.g., by a rib **44** on the underside of upper part **42** that runs longitudinally, which engages in a corresponding longitudinal groove **45** in the lower part **43**. The upper part **42** is preferably manufactured of metal, especially of steel, or at least the surface turned toward the concrete is manufactured of it, whereby this surface can additionally be coated to simplify removal of the upper part **42** after the casting in concrete and adequate reinforcement of the concrete before the concrete hardens. This removal of the upper part **42** is possible, since the upper part **42** forms only non-undercut sections **2** of the groove **1**. In contrast to this, the lower part **43** of the forming element **43** also forms at least the undercut sections **3** of groove **1** so that when the upper part **42** is pulled out of the concrete, which is not yet hardened, the lower part **43** is held back by the concrete and remains in the concrete slab **4**. The lower part **43** is not removed from groove **1** and/or the undercut sections **3** until after the concrete hardens, whereby it is destroyed. The lower part **43** thus forms a lost form. Advantageously, the lower part **43** of the forming element **33** consists of a relatively soft, and thus easy to remove material, for example foam, plastic or wood.

Alternatively, the lower part **43** can also be inserted on pins that extend downward from upper part **42** so that it is attached on

upper part **42** in such a way that it can be detached, whereby depending on the material used, lower part **43** does not have to have any corresponding recesses.

The forming element **33** according to the second embodiment described above can be positioned in the desired position before, during or after the concrete is poured for concrete slab **4**, especially by apparatus **30** by means of a holding device **41** engaging on the forming element and held until the concrete is poured or during the pouring. With subsequent placement of the forming element **33** into the concrete that is still capable of flowing, it is advantageous to previously roughly form the groove 1 to be created, e.g., by a corresponding form element that is moved along with a slip form paver or the like producing the concrete slab **4**, in order not to make excessive concrete displacement necessary during the later placement of the forming element **33** in the concrete. Alternatively, or additionally, it is provided that the forming element **33** is placed in the flowing concrete and positioned in the desired position by shaking.

Fig. 10 shows a third embodiment of the forming element **33** in a view corresponding to Figs. 7 and 9. This forming element **33** corresponding to the forming element **33** shown in Fig. 9 is encased “floating” in concrete, i.e., is positioned in the desired position formation of groove **1** before, during or after the concrete of concrete slab **4** is poured and encased with the flowing concrete. In contrast to

the second embodiment, the forming element **33** according to the third embodiment remains in the concrete slab **4** and forms the wall of the groove **1** to be produced. To do this, the forming element **33** is formed as a hollow profile that is open toward the top, e.g., essentially corresponding to the longitudinal profile **34** according to Fig. 7, made of a material having the necessary material properties and with adequate wall thickness, whereby if necessary the longitudinal edges 46 pointing upward can be formed higher than necessary in order to preclude, with certainty, a flowing of the concrete during manufacturing of the concrete slab **4** and/or the placement of the forming element **33** into the concrete that is still capable of flowing. If necessary, these edges **46** projecting over the upper surface of the concrete slab can be cut off after the concrete hardens.

For positioning and holding and/or placement of the forming /6
element **33** according to the third embodiment, the device **40** or a similar device can be used so that, for example, two forming elements **33** can be positioned parallel to each other simultaneously for forming two grooves **1** running parallel to each other and be encased with concrete. During continuous manufacturing of the concrete slab **4** by a slip form paver, etc., the forming element **33** can be installed in the concrete slab **4**, already be roughly aligned in the concrete slab **4** by the slip form paver even before that, for example by means of the positioning shoe **47** shown in Fig. 10 that engages with form fit, which glides along in the forming element **33** guided by a slip form paver.

Alternatively, or additionally, the forming element can be correctly aligned according the third embodiment, e.g., by means of the device **40** with the use of the positioning shoe **47**, as long as the concrete still has adequate flowing and forming capabilities.

Fig. 11 shows a fourth embodiment of the forming element in an illustration corresponding to Figs. 7, 9 and 10. In this case, the forming element **33**, basically corresponding to forming element **33** shown in Fig. 10 according to the third embodiment, can be installed in the concrete slab **4** and remains in the concrete slab **4**, whereby the forming element **33** forms the walls of the groove **1** to be formed. In contrast to the third embodiment, the forming element **33** has no longitudinal recess **48** or has one with a cross section that is at least reduced in comparison to the desired groove cross section or deviates from it completely. For example, the longitudinal recess **48** is slot-shaped, as shown, or, e.g., formed so that it is T-shaped in cross section. After the forming element **33** is installed in the concrete slab **4** and the concrete hardens, the desired groove profile is machined into the forming element **33** in the desired position. To do this, the surfaces of the forming element **33** that point inward are removed as much as necessary, e.g., with the device **22**, in order to obtained the desired groove profile, as indicated as an example by the dotted line.

The forming element **33** according to the fourth embodiment has the advantage that, with appropriate material selection, the machining of

groove **1** is relatively simple, e.g., using cutting machining with high precision and high working speed with relatively low costs. In addition, the forming element **33** can be installed with relatively high tolerance into the concrete slab **4**, e.g., by a slip form paver, so that together with the relatively simple later machining, a cost-effective manufacturing of grooves with the desired precision becomes possible.

It should be noted that the cross section shapes of groove **1** shown represent embodiment examples, but cross sections deviating from them can be provided depending on the application and requirement.

The concrete slab **4** can be manufactured on site, by means of a paver or the usual form. However, alternatively, the concrete slab **4** can be formed by ready-to-use parts. In this case, the grooves **1** are then alternatively manufactured and/or machined before installation of the ready-to-use parts, e.g., during their manufacturing, or after installation of the ready-use-parts on site, e.g., by milling.

Further, it should be noted that the term concrete "with flow capability" is generally understood as concrete in a consistency such that a deformation capability, e.g., by shaking, is still possible even if a certain amount of hardening, especially staying power already exists.

Patent Claims

1. Method for manufacturing grooves (1) that run parallel to each other with non-undercut sections (2) and undercut sections (3) in a concrete slab (4), especially for holding elastically deformable

profile elements (5) and track rails (7) that can be inserted in them for forming a ballastless superstructure (8) for a track, characterized in that the non-undercut sections (2) and the undercut sections (3) of the grooves (1) are milled into the hardened concrete slab and/or in the concrete slab (4) in separate steps.

2. Method according to Claim 1, characterized in that first he non-undercut sections (2) are milled and then the undercut sections (3).

3. Method according to any one of the preceding claims, the non-undercut sections (2) of the grooves (1) are milled using roller-shaped milling cutters (30) characterized in that

4. Method according to any one of the preceding claims, characterized in that the undercut sections (3) of the grooves (1) are milled by means of sloped milling or cutting disks (12).

5. Method according to any one of the preceding claims, characterized in that in each case, two grooves (1) are simultaneously milled by means of milling devices (27) that are connected to each other.

6. Method according to any one of the preceding claims, characterized in that the grooves are previously formed with reduced, e.g. slot-shaped groove cross section in the concrete that still has flow capability of the concrete slab (4) and/or are previously milled after the concrete hardens.

7. Method for manufacturing grooves (1) that run parallel to each other with undercut sections (3) in a concrete slab (4), especially

for holding elastically deformable profile elements (5) and track rails (7) that can be inserted in them for forming a ballastless superstructure (8) for a track, characterized in that the forming element (33) forming the grooves (1) are aligned and are encased with concrete when the concrete of the concrete slab (4) is poured or in recesses of the concrete slab (4).

8. Method according to Claim 7, characterized in that the forming element (33) are fixed so that they are aligned on a substrate (36), especially manufactured of asphalt and then encased with concrete.

9. Method according to Claim 8, characterized in that forming element (33) forming two grooves (1) are held by holding devices (41) that can be adjusted together and released and preferably fixed on the substructure (36) by screws (37) or pins.

10. Method according to Claim 7, characterized in that the forming elements (33) are held at least roughly position by a holding device (41) that can be removed and then encased with concrete.

11. Method according to Claim 7, characterized in that, after the concrete is poured in the concrete slab (4), the forming element (33) are placed in the concrete that still has flow capability, especially by shaking and especially in pairs by means of a common positioning device. /7

12. Method according to one of Claims 7 to 11, characterized in that, after being encased with concrete in the concrete that still has flow capability, the forming elements (33) are precisely aligned, especially simultaneously in pairs by means of a common positioning

device (25).

13. Method according to one of Claims 7 to 12, characterized in that multi-part forming elements (33) with upper parts (42) forming the non-undercut section of the grooves and lower parts (43) forming the undercut sections (3) of the grooves are encased with concrete, whereby the upper parts are removed before the concrete hardens and the lower parts (43) are removed after it hardens.

14. Method according to one of Claims 7 to 12, characterized in that forming elements (33) consisting of solid material or provided with reduced, e.g. only slot-shaped groove cross section, are encased with concrete and that after hardening of the concrete, the grooves (1) are milled into the forming element (33) and/or milled in them again, especially according to one of Claims 1 to 5.

15. Ballastless superstructure (8) for a track with grooves (1) that run parallel to each other in a concrete slab (4) for holding elastically deformable profile elements (5) and track rails (7) that can be inserted into them, whereby each groove (1 has and essentially slot-shaped section (15) and at least one undercut section (3) following on the underside, characterized in that the inclination (α) of the angled groove wall of the undercut section (3) to the center plane (14) of the slot-shaped section (15) is smaller than the diagonal (18) that defined by the longitudinal edge (16) at the transition from the angled groove wall to the slot-shaped section (15) and the longitudinal edge (17) of the slot-shaped section lying on the top section lying on the top, diagonally opposite, in the cross

section.

16. Device for manufacturing two grooves (1) that run parallel to each other with undercut sections (3) in a concrete slab (4), especially for holding elastically deformable profile elements (5) and track rails (7) that can be inserted in them for forming a ballastless superstructure (8) for a track, especially for carrying out a method according to one of Claims 1 to 5, characterized in that the device (22) comprises a carrying device (23) that spans the two grooves (1), especially a movable one, a positioning device (27) that is carried by it and can be adjusted with respect to it with at least two milling devices for simultaneously milling the two grooves (1) in the concrete slab (4) and an adjusting device (28) for adjusting the positioning device (25) relative to the carrying device (23) for common alignment of the milling devices (27).

17. Device according to Claim 16, characterized in that each milling device (27) has at least one first, preferably roller-shaped, milling cutter (30) for milling a non-undercut section (2) of a groove (1) and at least one second milling cutter (31) that is preferably disk shaped and preferably mounted downstream for milling an undercut section (3) of this groove (1).

18. Device for manufacturing two grooves (1) that run parallel to each other with undercut sections (3) in a concrete slab (4), especially for holding elastically deformable profile elements (5) and track rails (7) that can be inserted in them for forming a ballastless superstructure (8) for a track, especially for carrying out a method

according to one of Claims 7 to 14, characterized in that the device (40) has a carrying device (23) that spans both grooves and especially can be moved, a positioning device (25) that is held by it and can be adjusted relative to it with two holding devices (41) for holding two forming elements encased with concrete in the concrete slab (4) forming the two grooves (1) and can be released and an adjusting device (28) for adjusting the positioning device (25) relative to the carrying device (23) for common alignment of the two forming elements (33).

19. Forming element (33) for manufacturing grooves (1) that run parallel to each other with non-undercut sections (2) and undercut sections (3) in a concrete slab (4), especially for holding elastically deformable profile elements (5) and track rails (7) that can be inserted in them for forming a ballastless superstructure (8) for a track, especially for a method according to one of Claims 7 to 13, characterized in that the forming element (33) has an upper part (42) that at least partially forms the non-undercut sections (2) of a groove (1) and lower part (43) that at least partially forms the undercut sections (3) of this groove (1) that can be connected to the upper part by plugging it in, in a way so that it can be removed.

20. Forming element according to Claim 19, characterized in that the upper part (42) consists at least partially of steel, which is preferably coated, and that the lower part (43) consists of a relatively soft material, especially plastic, foam or wood.

11 Page(s) of drawings follow

Nummer: DE 197 53 705 A1
Int. Cl.^{6}: E 01 B 37/00
Offenlegungstag: 10. Juni 1999

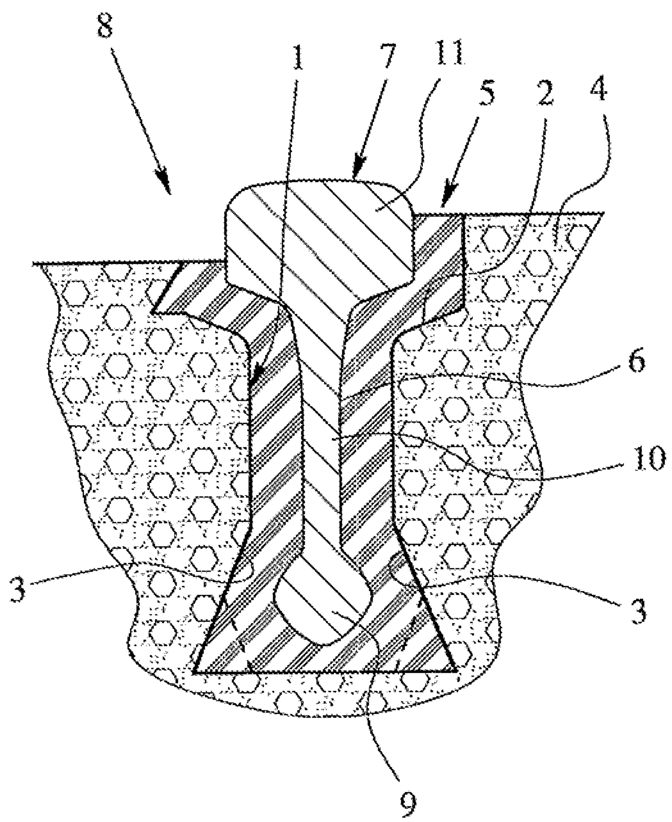

Fig. 1

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Offenlegungstag: 10. Juni 1999

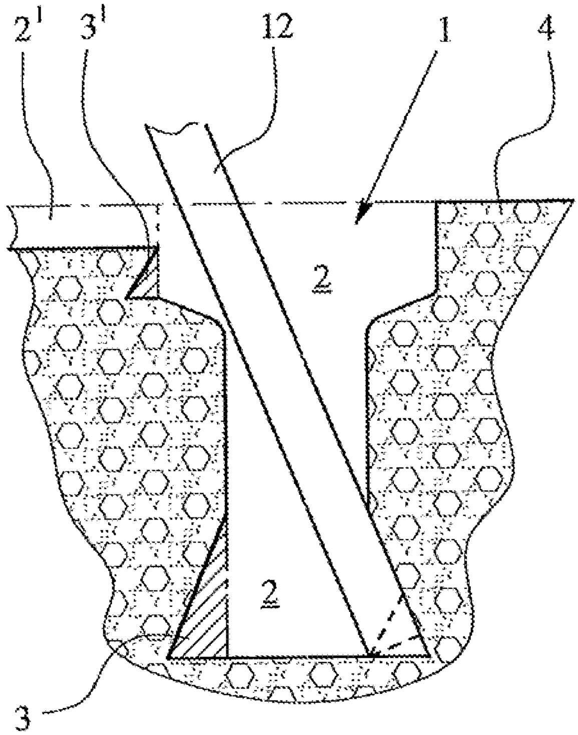

Fig. 2

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Int. Cl.[6]: E 01 B 37/00
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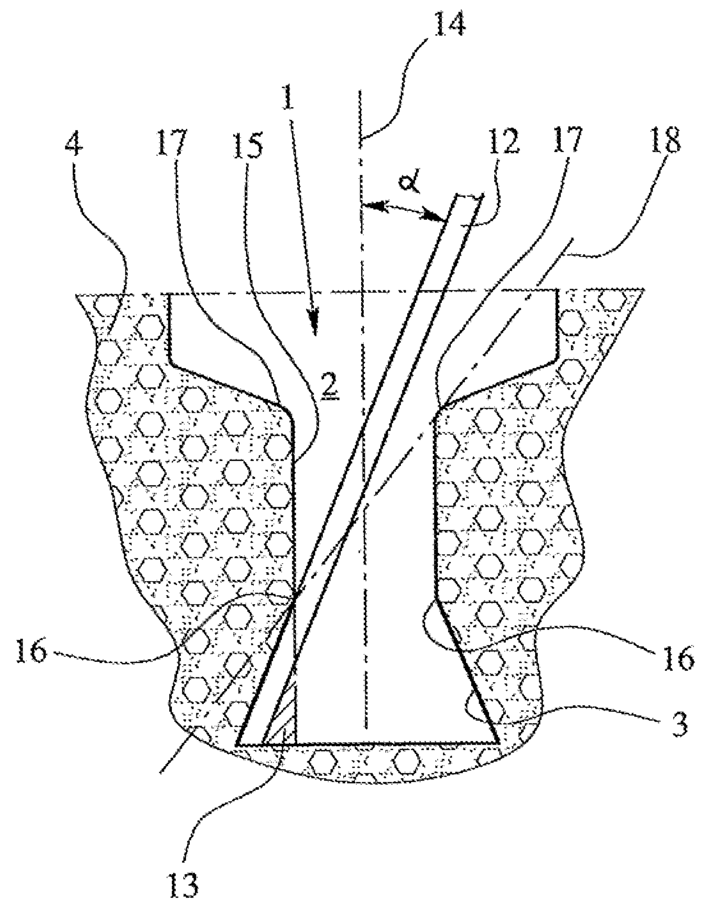

Fig. 3

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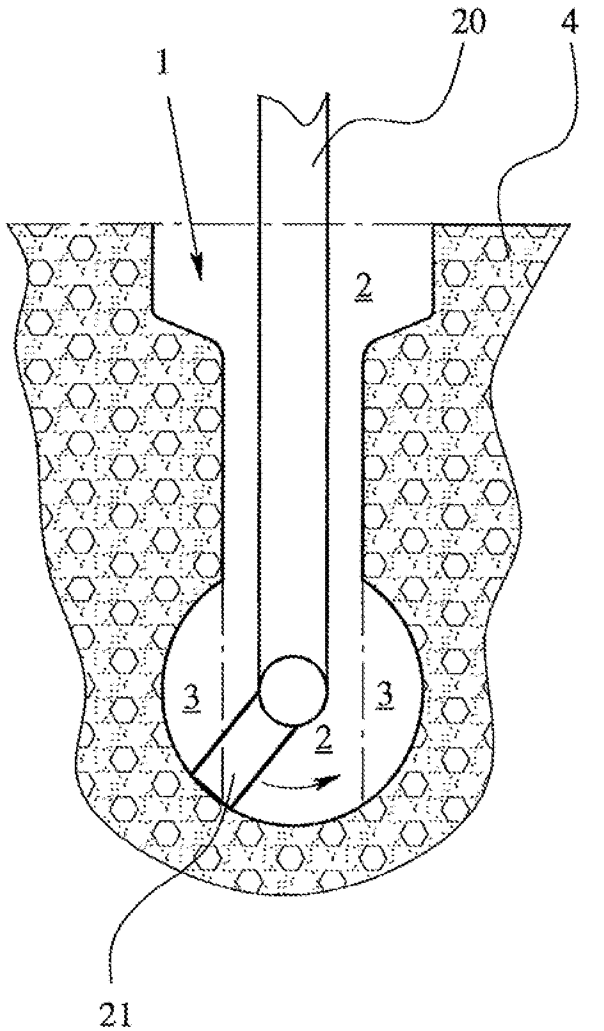

Fig. 4

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Offenlegungstag: 10. Juni 1999

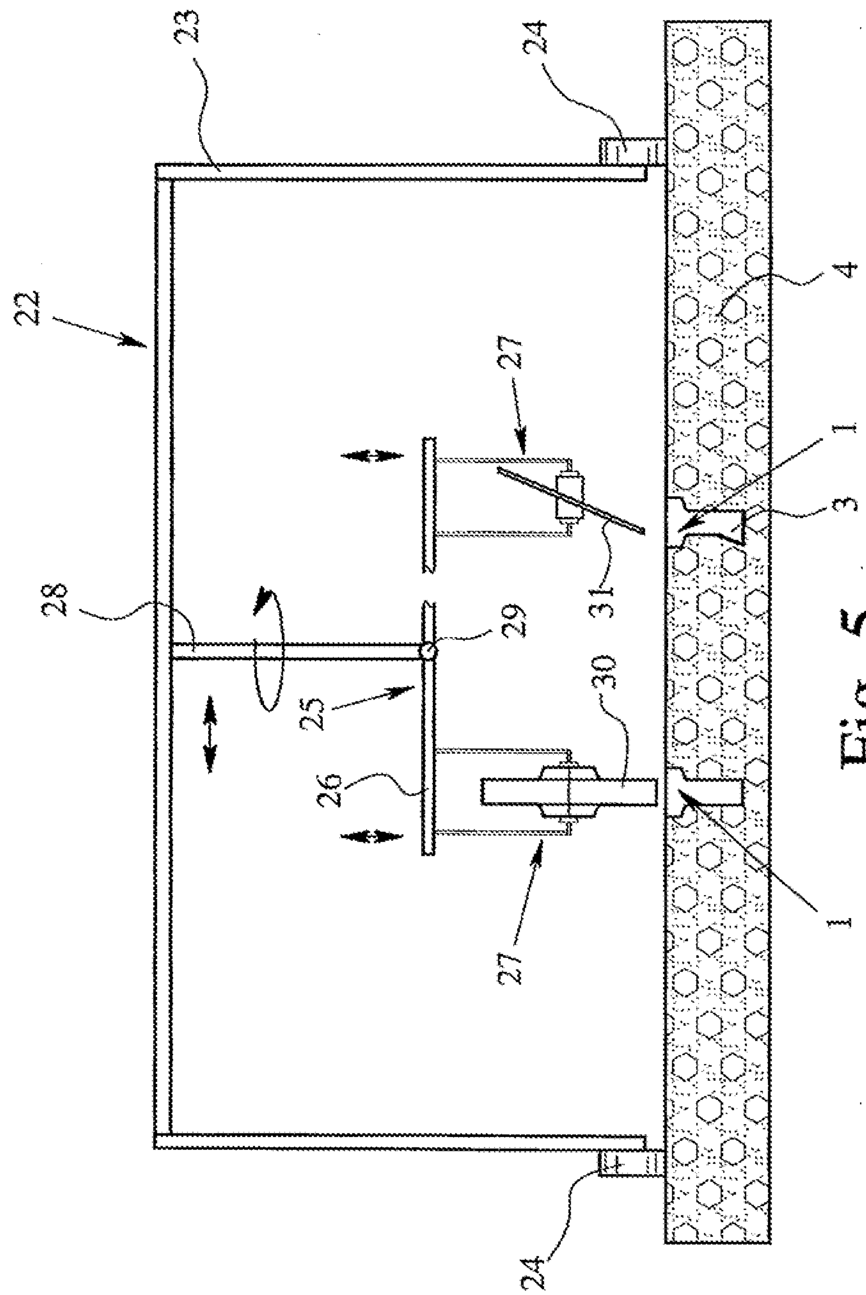

Fig. 5

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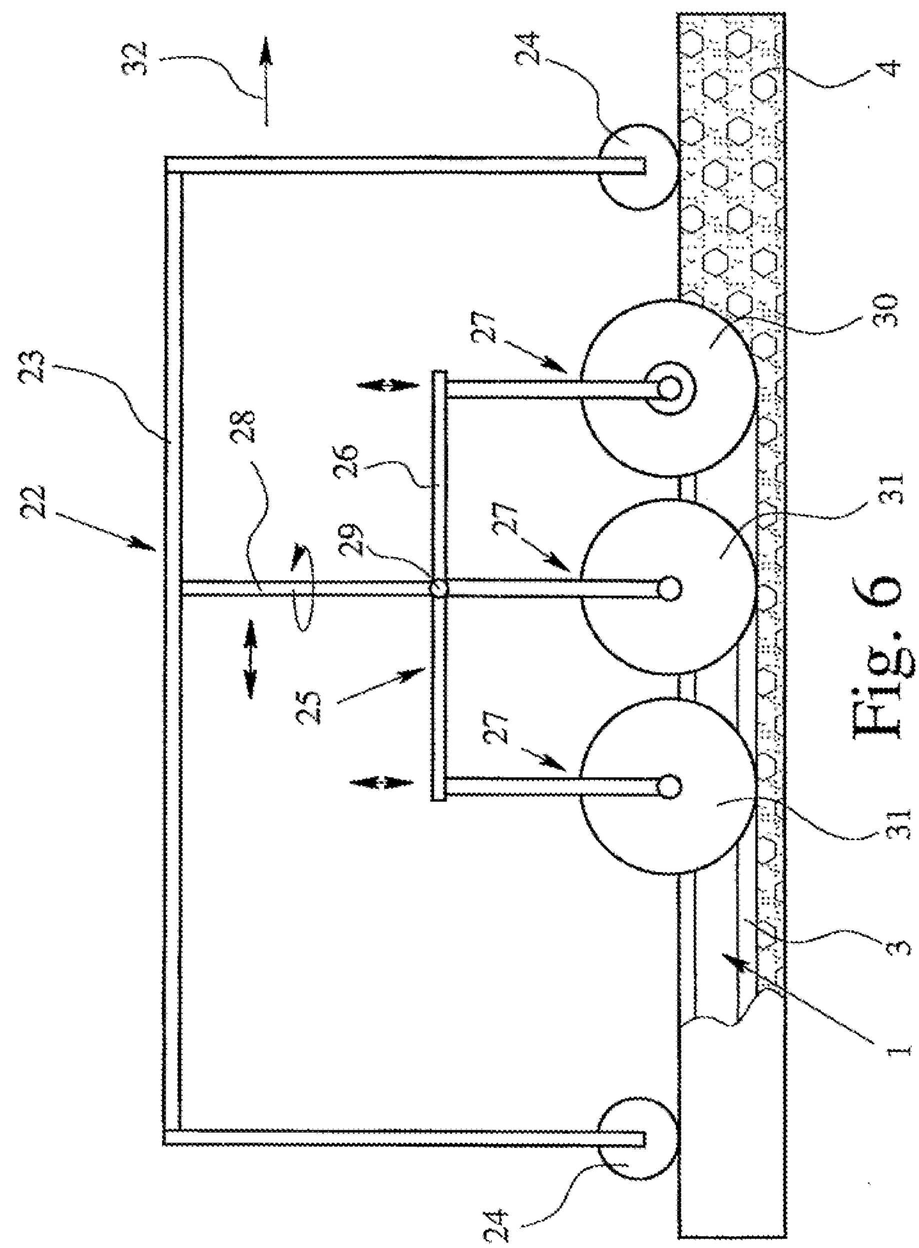

Fig. 6

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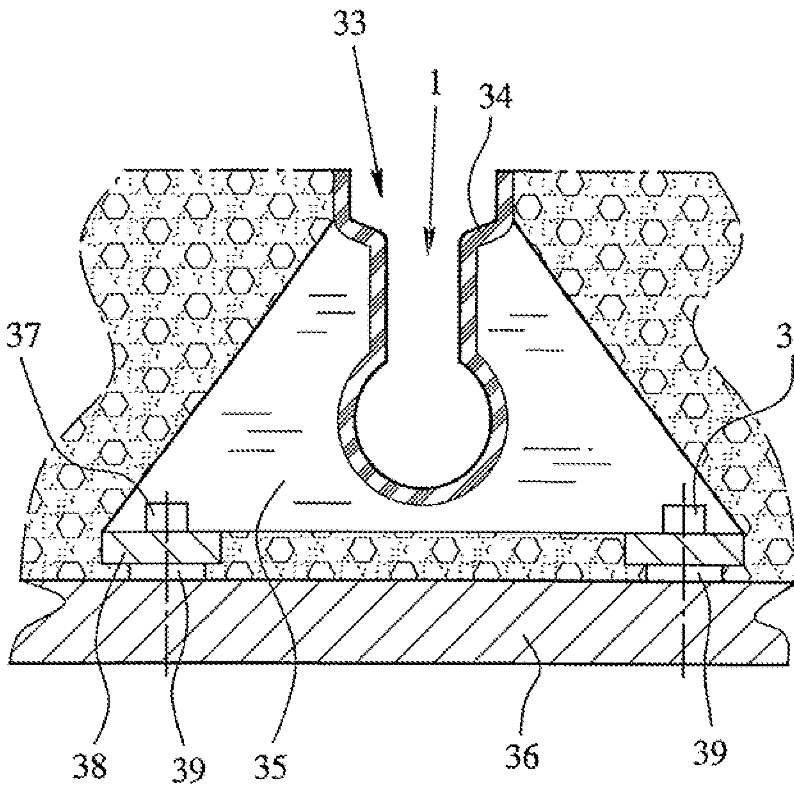

Fig. 7

ZEICHNUNGEN SEITE 8

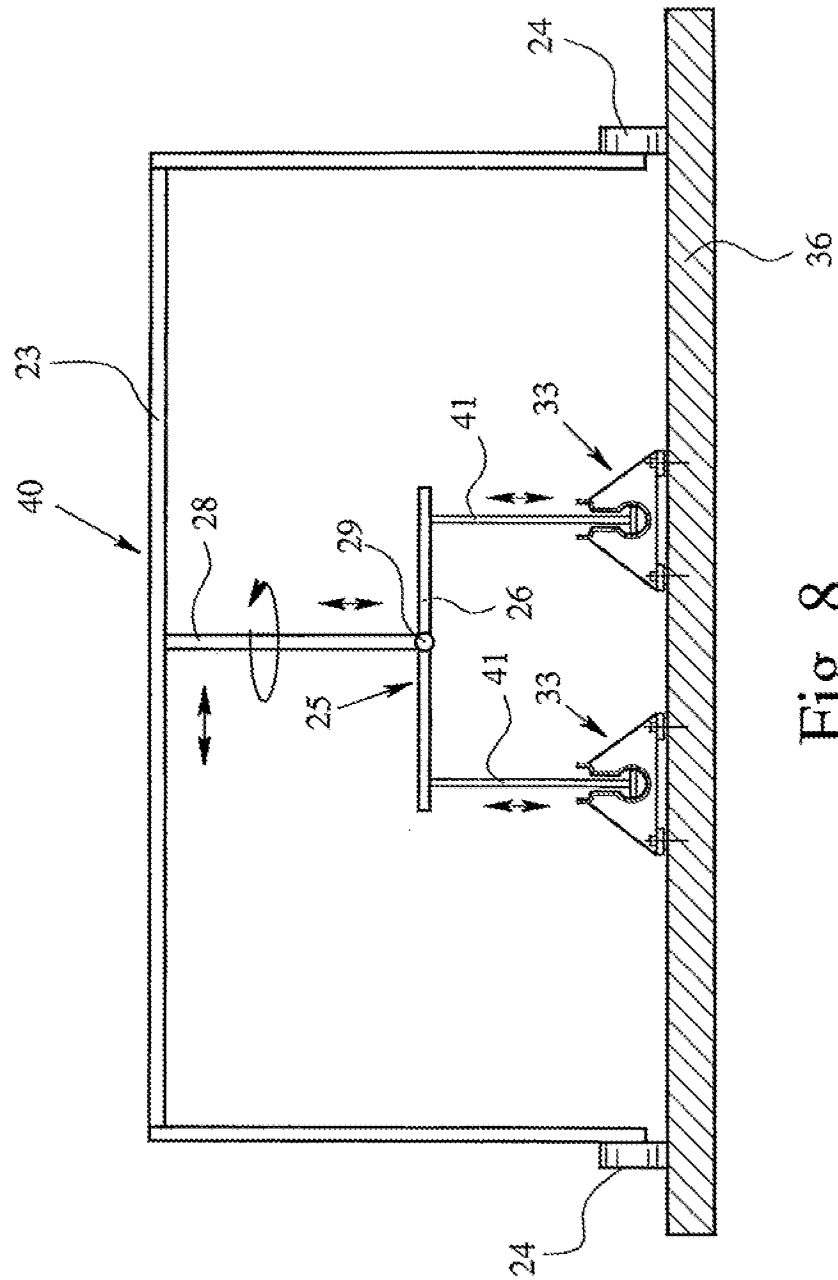

Fig. 8

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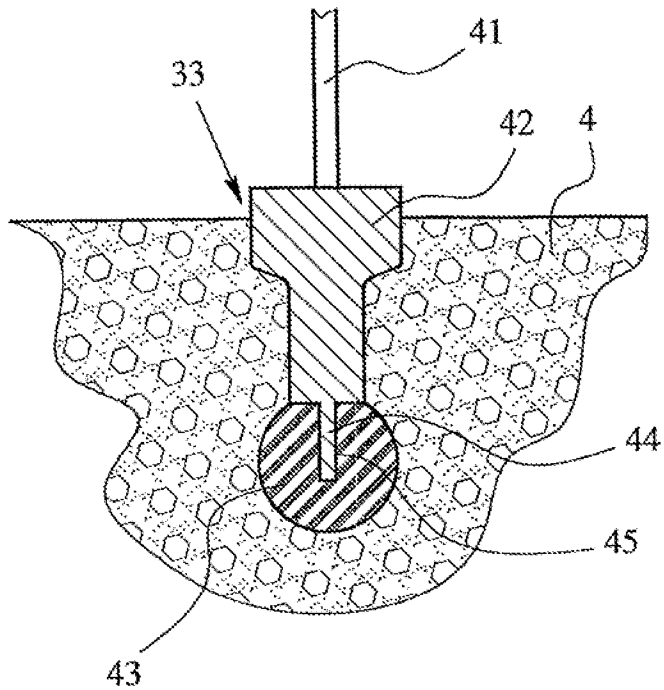

Fig. 9

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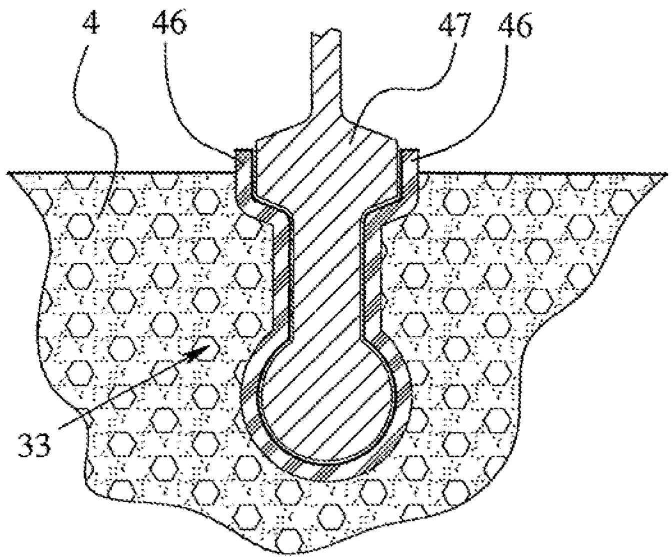

Fig. 10

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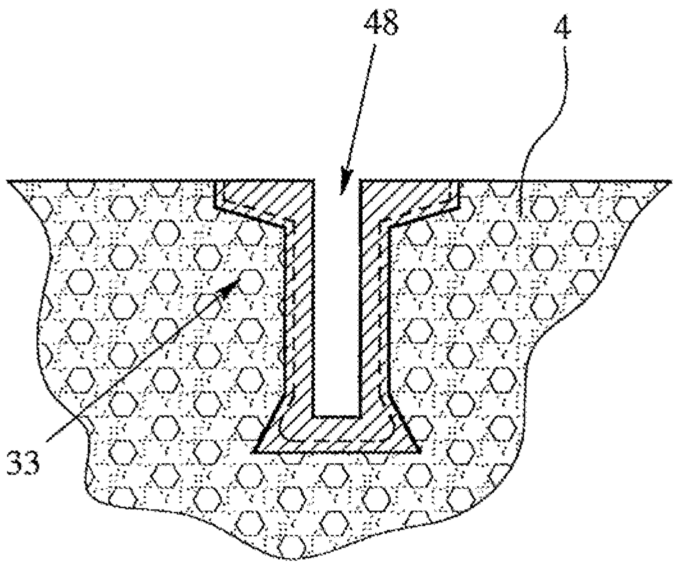

Fig. 11